

WHAT IS CLAIMED IS:

1           1.     An integrated Low Dropout (LDO) linear voltage regulator providing improved  
2     current limiting, comprising:

3           a 2-input, 1-output differential voltage amplifier, a first input receiving a reference  
4     voltage;

5           a circuit to sense the output voltage of the voltage regulator and couple it to a second  
6     input of the differential voltage amplifier in a manner that provides negative feedback;

7           a series pass transistor connected to the output of the difference voltage amplifier;

8           a current sense transistor coupled to the series pass transistor using current mirroring to  
9     monitor the current passing through it;

10          a reference current source coupled to the output of the current sense transistor; and

11          the junction of the current sense transistor and the reference current source being  
12     connected to the difference voltage amplifier in a manner that increases an apparently sensed  
13     output voltage as the current through the current sense transistor exceeds the reference current  
14     value.

1           2.     The integrated Low Dropout (LDO) linear voltage regulator as in claim 1,  
2     wherein the differential voltage amplifier is a long-tailed pair having a constant current source  
3     for providing a tail current.

1           3.     The integrated Low Dropout (LDO) linear voltage regulator as in claim 1,  
2     wherein the circuit for sensing the output voltage of the voltage regulator comprises a direct  
3     connection of the output of the voltage regulator to the second input of the difference amplifier.

1           4.     The integrated Low Dropout (LDO) linear voltage regulator as in claim 2,  
2     wherein the junction of the current sense transistor and the reference current source is connected  
3     to the control terminal of a current limiting transistor that is connected in parallel with the  
4     transistor of the long-tailed pair that has its control terminal as the second input of the difference  
5     amplifier.

1           5.     A method for improving current limiting in an integrated low Drop Out (LDO)  
2 linear voltage regulator, comprising:

3                   receiving a reference voltage at a first input of a difference voltage amplifier;

4                   sensing a regulator output voltage;

5                   applying the sensed regulator output voltage to a second input of the difference  
6 voltage amplifier in a manner that provides negative feedback;

7                   sensing current passing through the regulator output;

8                   comparing the sensed current to a reference current; and

9                   controlling operation of the difference voltage amplifier in a manner that  
10 increases the apparently sensed regulator output voltage if the sensed current exceeds the  
11 reference current.

1           6.     The method as in claim 5, wherein applying the sensed regulator output voltage  
2 comprises directly connecting the sensed regulator output voltage regulator to the second input  
3 of the difference voltage amplifier.

1           7.     A low drop-out voltage regulator, comprising:  
2                 a differential amplifier stage including:  
3                     a differential amplifier having first and second differential inputs, the first  
4     differential input coupled to an output of the regulator and the second differential input coupled  
5     to a reference voltage; and  
6                 a current control transistor coupled to one branch of the differential  
7     amplifier; and  
8                 an output stage including:  
9                     a pass transistor coupled between a regulator input and the regulator  
10    output and controlled by an output of the differential amplifier; and  
11                     a current sensing transistor coupled between the regulator input and the  
12    current control transistor of the differential amplifier.

1           8.     The regulator of claim 7 wherein a first reference terminal of the differential  
2     amplifier is coupled to the regulator input and a second reference terminal of the differential  
3     amplifier is coupled to ground.

1           9.     The regulator of claim 8, wherein the differential amplifier stage further includes  
2     a tail current transistor coupled between the second reference terminal and ground.

1           10.    The regulator of claim 7, wherein the output stage further includes a biasing  
2     transistor coupled between the pass transistor and ground.

- 1           11.    The regulator of claim 7, wherein the output stage further includes a current  
2   limiting transistor coupled between the current sensing transistor and ground.

1           12.    A regulator, comprising:  
2                   a regulator input;  
3                   a regulator output;  
4                   a differential amplifier coupled to the regulator input and having first and second  
5 current paths associated with corresponding first and second differential input and an output in  
6 the second current path, the first differential input coupled to the regulator output and the second  
7 differential input receiving a reference voltage;  
8                   a current control transistor coupled to a first current path;  
9                   a pass transistor coupled between the regulator input and regulator output and  
10 having a control terminal coupled to the differential amplifier input; and  
11                   a current sensor to sense current at the regulator output and generate a control  
12 signal applied to the current control transistor.

- 1           13.    A method, comprising:
- 2                   sensing an output regulated voltage;
- 3                   comparing the output regulated voltage to a reference voltage;
- 4                   controlling the output voltage through negative feedback to substantially match
- 5 the reference voltage;
- 6                   sensing a current associated with the output voltage;
- 7                   comparing the sensed current to a reference current;
- 8                   if the sensed current exceeds the reference current, then overriding the sensing of
- 9 the output regulated voltage to sense an apparent, higher, voltage.

1           14.    A regulator, comprising:  
2                   a negative feedback voltage control circuit that senses an output regulated voltage  
3   and controls that sensed output regulated voltage to substantially match a reference voltage;  
4                   a current sensor that senses a current associated with the output regulated voltage  
5   and compares the sensed current to a reference current; and  
6                   a feedback control circuit responsive to sensed current exceeding the reference  
7   current to override the negative feedback voltage control circuit sensing of the output regulated  
8   voltage to sense an apparent, higher, voltage.

1           15.    The regulator of claim 14 wherein the negative feedback voltage control circuit  
2   comprises:  
3                   a differential amplifier including first and second mirrored current paths, a current  
4   flowing in the first current path being controlled by the output regulated voltage, and a current  
5   flowing in the second current path controlling the sensed output regulated voltage to  
6   substantially match the reference voltage;  
7                   an override circuit coupled to the first current path and responsive to the feedback  
8   control circuit to maintain current flowing in the first current path as the output regulated voltage  
9   decreases.